POPULATION SIZE AND GEOGRAPHICAL DISTRIBUTION OF CLEMATIS FREMONTII VAR. RIEHLII

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Population size has very important bearings on evolutionary processes in any organism. As Dobzhansky (1941, p. 169) has pointed out, however, estimates of population size are available for only a few plants or animals. Among plants, the only such estimates are those of Anderson (1936) on *Iris*, and Emerson (1939) on *Oenothera organensis*. This paper presents detailed distributional data for *Clematis Fremontii* var. *Riehlii*, and a preliminary estimate of its population size.

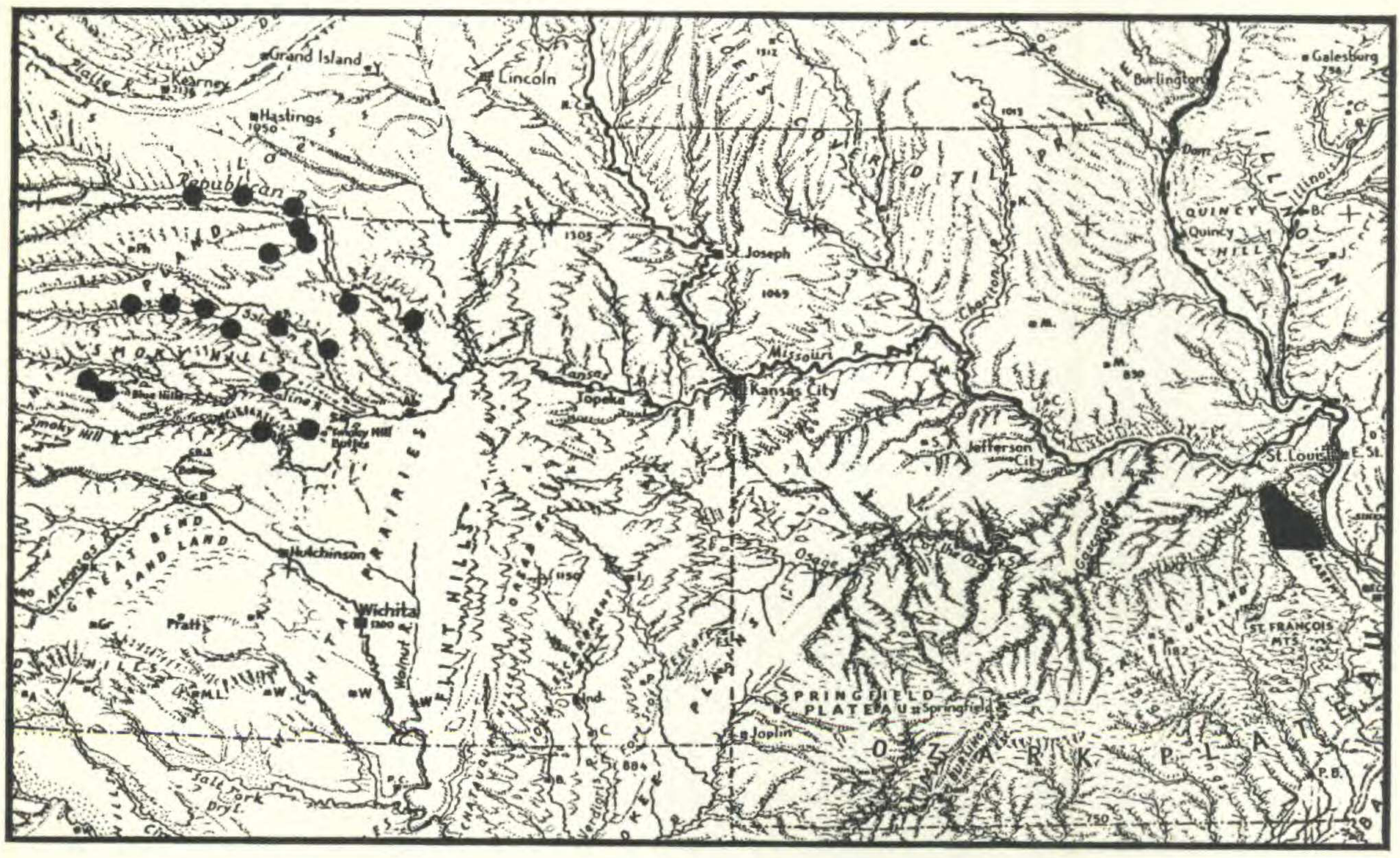

Fig. 1. Distribution of *Clematis Fremontii* (dots) and of *C. Fremontii* var. *Riehlii* (solid black). Base map by Erwin Raisz, reproduced from Atwood's 'Physiographic Provinces of North America', by permission of Ginn & Co.

Clematis Fremontii S. Wats., in its unrestricted sense, has a unique, disjunct distribution, being known from an area of roughly 10,000 square miles in north-central Kansas and adjacent Nebraska, and occurring again in eastern Missouri, where it is nearly limited to Jefferson County (fig. 1). A study of the available herbarium material has revealed some differences between the two branches of

the species. This point is discussed by Erickson (1943), and has been made the basis for proposing the name *C. Fremontii* var. *Riehlii* Erickson for the Missouri plants.

The limited range of *C. Fremontii* var. *Riehlii*, together with some other features of its distribution, and its vegetative characteristics, has recommended it for a detailed distribution study. It occurs exclusively on dolomitic glades, a well-marked type of habitat which has been described by Erickson, Brenner and Wraight (1942). The map which forms fig. 1 of that paper covers the range of *C. Fremontii* var. *Riehlii*, and was prepared as a preliminary to this study from tracings of aerial photographs. Fig. 2 of this paper is a reproduction of that map with the addition of the distribution data so far collected. The solid circles represent places in which *Clematis* has been seen. They have no numerical significance, some of them being based on finding of a single plant, others representing colonies of several thousand. The open circles are placed over glades on which *Clematis* has not been found after a reasonably thorough search. The plants are large enough and distinctive enough in appearance to be recognized at a distance of 200 or 300 yards. In many cases it has been possible to see *Clematis* on a glade without leaving the automobile, and it has been spotted by the use of field glasses. The leaves are thick and woody, so that the plants persist on the glades for over a year after flowering; this fact has made it possible to carry on some phases of field work throughout the year.

While it was often a simple matter to ascertain the presence of *Clematis* on a glade, more painstaking methods were used for the negative records. The plant has not been recorded as absent from a glade unless the glade has been visited on foot. For a small glade it was usually sufficient to walk from one end to the other; for a larger glade a zigzag course from top to bottom of the glade was followed, or two trips were made across it, one near the top edge, and the other near the bottom.

It can be stated with considerable confidence that *C. Fremontii* var. *Riehlii* does not occur outside the area outlined on the map (fig. 2). In Palmer and Steyermark's (1935, p. 542) catalog the plant is reported as occurring in St. Louis, Jefferson, Franklin, St. Francois and Washington counties. Its occurrence in Jefferson, Franklin and Washington counties has been repeatedly verified in this study. The St. Louis County record is undoubtedly based on the specimens collected by Letterman, labelled Allenton, and by Kellogg, labelled Allenton and Eureka (Erickson, 1943, p. 41). While the villages of Allenton and Eureka are in St. Louis County, the writer is convinced that the collections were made across the Meramec River in Jefferson County. An unsuccessful search has been made north of the Meramec, all along the outcrop of the Joachim formation, the only likely place. This view is supported by a half-dozen letters which Letterman wrote to Dr. Engelmann in the spring of 1875. It appears from these letters that Letterman had explored the southwestern part of St. Louis County quite thoroughly; and that he was on the look-out for the *Clematis*. On June 24 he states, "I do

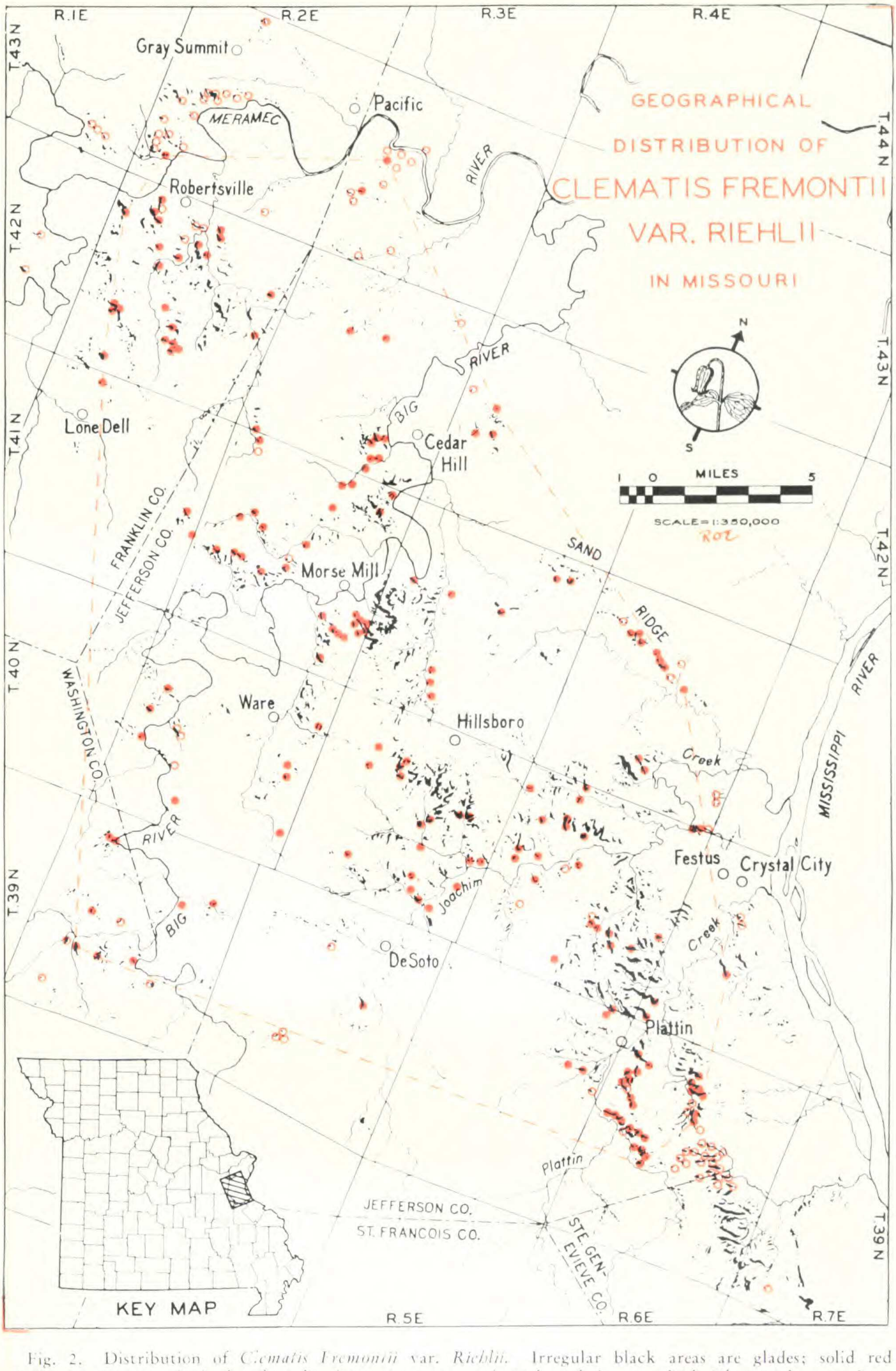

Fig. 2. Distribution of *Clematis Fremontii* var. *Riehlii*. Irregular black areas are glades; solid red circles, stations at which the plant has been seen; open red circles, glades on which *Clematis* has not been found after search.

Fig. 3. Mature plant of *Clematis Fremontii* var. *Riehlii* growing on glade shown below. Scale at right is in centimeters.

Fig. 4. Portion of glade 2 miles southwest of Robertsville, Franklin Co., Mo. (R.2E, T.42N, S.7, N.W.¼), showing plants of *Clematis Fremontii* var. *Riehlii* in foreground. Photographs taken April 27, 1942.

not remember having seen the Clematis [undoubtedly *C. Fremontii* var. *Riehlii*] in any of my rambles." He was fond of crossing the Meramec at Hunter's Ford and collecting in Jefferson County; and he later found the plant, his collections bearing various dates from 1880 to 1893. Kellogg's St. Louis County collections are probably to be interpreted in the same way.

The St. Francois County record does not appear to be supported by any herbarium specimen; *Clematis* has not been found on several glades in St. Francois County which have been visited in the course of this study. Steyermark has apparently collected the plant in Ste. Genevieve County.[1] It has not been possible to verify this record although three visits have been made to Beckett Hills for that purpose. Unsuccessful search has also been made for the *Clematis* in a number of other scattered localities which lie outside the area of the map.

Of the 160-odd positive records plotted in fig. 2, about 15 occur in places where no glades are indicated. In all of these cases the *Clematis* was found on glades which are quite small and were overlooked in tracing the photographs. The error arising from failure to investigate other unrecorded small glades is much less than the ratio of 15 to 160, because of the small numbers of plants on such glades as compared with the large numbers represented by many of the other dots.

The area occupied by the *Clematis* was outlined on the map (fig. 2) by connecting outlying dots with straight lines. By weighing a paper cut-out of the resulting polygon, the area was found to measure 436 square miles. For R.3E, T.41N, S.1-18, the total area in glades was measured by placing the photo tracings over a piece of paper ruled in small squares and counting the squares covered by the glade outlines. In these 18 square miles, the glade area is 1.6 percent of the total area. Assuming this percentage to be characteristic of the entire range of the *Clematis*, the glades on which it occurs occupy a total area of 7.0 square miles.

A few population density counts have been made. On a glade in R.6E, T.39N, S.4, 2½ miles east of Plattin, 1067 plants were counted in an area of 0.865 acre, a density of 794,000 plants per square mile of glade. In R.2E, T.42N, S.10, 2 miles southeast of Robertsville, 578 plants were counted in 2.33 acres, about three-fourths of a small glade. This represents a density of 160,000 plants per square mile of glade. Multiplied by 7.0 square miles, these densities give values for the total population of 5,550,000 and 1,120,000 respectively. The true value probably lies nearer the lower number.

In R.3E, T.41N, S.25, southeast of Morse Mill, the total number of plants was estimated as 5040. Ten-foot strips were laid out at 250-foot intervals across all the glades in the section, the plants were counted in these strips, and the estimate for the entire square mile was made from this sampling. Multiplying 5040 by 436 square miles gives 2,200,000 as the total population of *C. Fremontii* var. *Riehlii*, a

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[1] The specimens are labelled: Clematis Fremontii Wats., limestone glade in Beckett Hills, 2 mi. north of River aux Vases, Ste. Genevieve Co., No. 20926, Oct. 31, 1936, Julian A. Steyermark, Collector.

result which is of the same order of magnitude as the two estimates given above, although it was arrived at by a somewhat different method.

The absolute size of a population, however, does not have much meaning. Much more significant in evolutionary phenomena is Wright's "population number," the effective size of the breeding population (Dobzhansky, 1941). A number of factors besides absolute frequency are involved in the population number, such as (for this *Clematis*) size and proximity of the colonies, longevity of the plants, pollination radius, means and rate of seed dispersal, etc. An attempt to evaluate some of these factors is being made, and it is hoped that they may be discussed in a later paper.

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